Food safety is a key determinant of fruit and vegetable consumption in urban Beninese adolescents

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Keywords

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Running title

Determinants of fruit and vegetable intake in Beninese adolescents

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ABSTRACT

Objective: To identify the determinants of fruit and vegetable consumption in urban Beninese adolescents and elements to develop a school-based fruit and vegetable program.

Design: Sixteen focus groups conducted using a keyword guide.

Setting: Two private and two public secondary schools in Cotonou, Benin.

Participants: One hundred and fifty-three students aged thirteen to nineteen years, 54% girls.

Analysis: The focus groups were audio-taped, transcribed and analyzed using Nvivo 8 software. Three a priori categories from the Social Cognitive Theory were used for the coding: socio-environmental, personal and behavioral factors. Additionally, the data were checked to see whether new categories should be created.

Results: Major determinants in the school were availability and accessibility of fruits and vegetables, nutrition education and the competition of unhealthy foods. Food safety emerged as a strong barrier to the adolescents' fruit and vegetable consumption, outside home and particularly at school.

Conclusions and Implications: Except for food safety, the determinants of fruit and vegetable intake in Beninese adolescents were similar to those in high-income countries. The food safety of fruits and vegetables outside home is a key issue to be studied in-depth and integrated in any intervention in Benin and potentially other low- and middle-income countries.

(199 words)

Keywords: Fruit; vegetables; adolescent; determinants; Benin

INTRODUCTION

Rapid changes in diets and lifestyles over the past decade, due to urbanization, industrialization, economic development and market globalization, are increasing the prevalence of diet-related chronic diseases worldwide[1]. The situation is more alarming in low- and middle-income countries (LMIC) since diet-related chronic diseases are occurring at a faster rate than in high-income countries (HIC)[2]. Added to the burden of malnutrition, the consequences of chronic diseases on the health systems of LMIC are potentially huge[3].

An adequate consumption of fruits and vegetables is known to protect against chronic diseases such as several types of cancer and cardiovascular disease[4-7] and help manage weight[8]. A minimum daily intake of 400g of fruits and vegetables, equivalent to five portions of 80g each, is recommended[1;9]. Low intakes of fruits and vegetables are a common feature in LMIC. In a study in ten countries of sub-Saharan Africa for instance, the mean per capita consumption was far below the minimum recommended level in all countries and in eight of them, 85% of households failed to reach the minimum 400g of fruits and vegetables per day[10]. In a more recent study, a prevalence of low fruit and vegetable intake higher than 70% was observed among men and women in several sub-Saharan African countries like Burkina-Faso, Côte d'Ivoire, Senegal, Zambia and Zimbabwe[11].

In Benin, 85% of urban adults aged twenty-five to sixty-four years consume less than five portions of fruits and vegetables per day[12]. In a previous study in Cotonou, the largest city of the country, we observed a mean daily fruit and vegetable intake of 97g in school-going adolescents[13]. It is important to design interventions to promote the consumption of fruits and

vegetables in these adolescents since poor eating habits developed during adolescence tend to persist later in life[14;15]. As a first step, an insight into the factors determining the adolescents' fruit and vegetable intake is needed.

A lot is known about the determinants of fruit and vegetable intake in adolescents from HIC: home availability and accessibility of fruits and vegetables, personal preferences, parental intake, gender, age and socioeconomic status have been identified as major mediators[16;17]. However, there is a lack of information about the predicting factors in LMIC[18]. Determinants of fruit and vegetable consumption in adolescents from HIC and LMIC may differ because of a difference in socioeconomic and cultural context. Moreover, each population has a unique socioeconomic and cultural background and this makes the Beninese context a particular one. Our study assessed urban Beninese adolescents' perceptions regarding the factors that influence their fruit and vegetable intake. We hypothesized that the context-specific determinants of fruit and vegetable intake identified in urban Beninese adolescents will be different from those reported in HIC.

This study is expected to provide elements for the development of a school-based fruit and vegetable program. Schools are the places where most urban adolescents gather and are considered as appropriate settings for nutrition interventions in adolescents[19;20]. Studies performed in HIC reported several fruit and vegetable interventions with sustained effects years after their termination[21-25].

METHODS

PARTICIPANTS AND RECRUITMENT

We used focus group discussions which allow a more in-depth exploration of nutrition and health issues compared to less interactive tools like questionnaires[26]. A convenience sample was selected since focus groups findings are not intended for generalization[26]. The organization of the focus groups took into account family income and age, which are known to be important correlates of adolescents' fruit and vegetable intake[17]. Moreover, we previously found that family wealth mediates the dietary patterns of urban Beninese adolescents. Adolescents from better-off households eat more fruits and vegetables, more meat, more sweet foods but fewer cereal products than adolescents from poorer households ("Blinded" *et al*, unpublished data, 2010). Hence, we selected our sample considering family income and age. Type of school (private or public) was used as a selection criterion for family income. In Benin, adolescents attending private schools are generally from wealthier families than those from public schools. Two public secondary schools were identified, each in one of the most disadvantaged areas in Cotonou. Two private secondary schools were chosen, each from a better-off neighborhood in the center of Cotonou. The characterization of the neighborhoods of Cotonou is done by the city hall using the availability of public infrastructures. By choosing the public schools from the most disadvantaged areas and the private schools from the center of Cotonou, we increased the likelihood to end up with two groups of students at the two opposite edges of family income (the richest and the poorest). The school fees in the two private schools were three to eight times higher than in the two public schools.

The Beninese education system has four cycles: nursery school, primary school, secondary school and university. Secondary school goes from 11 to 18 years and corresponds to

middle school and high school in the system of the United States of America. It includes: a first grade called *sixième* (minimum 11 year-old), a second grade or *cinquième* (12 years), a third grade or *quatrième* (13 years), a fourth grade called *troisième* (14 years), a fifth grade or *seconde* (15 years), a sixth grade or *première* (16 years) and a seventh grade called *terminale* (17 years). There is no formal school food policy regulated by state institutions or by the school authorities themselves. In every school, there are street food vendors authorized to sell in the compound after a medical check-up. Their food offer is neither controlled by the school authorities nor by regular state agencies. They are free to be present every day or not and to stop their activity at any point in time. Students generally do not get a lunch pack.

In the four selected schools, third and fifth graders were informed of the study objective and invited to participate. Students at these school levels have more free time and can easily participate in extra-curricular activities. We considered a minimum age level of thirteen years appropriate to participate to the focus groups. We used the maximum age limit of the World Health Organization for adolescence (nineteen years). In each school, two focus groups were conducted per grade; this yielded four sessions with each category of participants: two with third graders from public and private school respectively, two with fifth graders from public and private school respectively. The number of focus groups was defined a priori before the survey started and considered sufficient to reach data saturation[26]. In total, sixteen sessions were held, with seven to ten students per session, depending on the number of students who volunteered and based on their reported age. Before the focus groups began, participants provided their date of birth, gender, school and grade on a form.

Prior to the survey, the authorization of the school authorities was obtained. Parents were informed of the study by a letter. We additionally requested from the voluntary participants to

sign or provide their initials on an informed consent form. Participants received apples as an incentive but were not informed of that before the discussions. The protocol of the study was approved by "blinded" ethics committee. The study was conducted in May 2009.

INSTRUMENT AND PROCEDURE

A discussion guide (**table**) was developed by the research team based on the Social Cognitive Theory (SCT), a commonly used method to predict dietary behavior[27]. The SCT is considered appropriate to assess factors relating to fruit and vegetable intake among children and adolescents[27] and has been used previously[28-30]. It states that dietary behavior is influenced by socio-environmental factors (like availability), personal factors (such as preferences) and behavioral factors (like meal patterns) and that those factors interact constantly. The interview guide was formulated as keywords to ensure consistency from one session to another while allowing some flexibility and adaptability to context. For some keywords, sample questions were added. The guide was pilot-tested in a convenience sample of ten fifth graders from a non-participating school and was modified subsequently.

An experienced anthropologist moderated the group discussions. They were conducted during school hours in a quiet classroom and lasted on average forty-five minutes. To make the participants feel comfortable, the discussion started with a brainstorming session on easy questions which were not used in the data analysis. The moderator moved further to key-questions about the determinants of the adolescents' fruit and vegetable intake such as availability, accessibility, knowledge and personal preferences. The questions referred particularly to the school environment and were asked separately for fruits and vegetables since

their determinants could differ. At the end of the focus groups, participants were asked what they considered to be a feasible and effective school-based fruit and vegetable intervention.

An assistant audio-recorded the discussions, took notes of non verbal signs and wrote summaries. Both the moderator and the assistant were Beninese and with a good knowledge of the cultural context and local names of fruits and vegetables. The language used during the focus groups was French. A full transcript (in French) was made soon after each session and checked for conformity with the audio-recordings.

DATA ANALYSIS

The transcripts were analyzed in French independently by two French-speaking researchers using a standard procedure. Three categories, identified from the SCT prior to the survey, served as the basis: socio-environmental, personal and behavioral factors. Relevant passages of transcripts were classified in these pre-determined categories. To avoid missing new important themes, the constant comparison method was used additionally[31]: each passage was checked and compared with the rest of the data to see whether it fitted one or more of the a priori categories or whether a new one was to be created. A discussion followed until consensus was reached about the coding of the data. Nvivo 8 software (QSR International Pty Ltd, Victoria, Australia) was used for coding and data analysis. Node and coding reports were used to see which factors occurred more than others and coding queries gathered quotes related to each factor. Summaries made during the interviews added to the understanding of students' ideas and to the good classification of pieces of transcripts. To present our results, quotes were translated into English. Determinants are presented per category of the SCT and

within a category, from the most discussed to the least mentioned by the adolescents. Examples of quotes are given for more clarity.

RESULTS

In total, one hundred and fifty-three students participated in the sessions, 54% were girls. Adolescents from private schools represented 49% of participants and third graders, 52%.

SOCIO-ENVIRONMENTAL FACTORS

Among socio-environmental factors, the availability and accessibility of fruits and vegetables appeared as the most discussed determinants at school as well as in the home environment.

Factors related to the school environment.

Availability and accessibility of fruits and vegetables. All the participants reported limited or no school availability and accessibility of fruits and vegetables. Accessibility related to the availability of fruits and vegetables in a form, at a place and at a time facilitating their consumption. For instance, somebody said:

'There is somebody selling fruits here, we have only one fruit seller; she sells oranges, mangoes and tamarinds (private school, fifth grade).'

In addition, the students pointed out that the quantity of vegetables served by the ladies selling prepared meals in the school compounds was small and depended on how much one can afford.

'In the sauce that accompanies rice, there are things like onions, pepper, tomatoes but in the bread, there are carrots but not much (public school, fifth grade).'

Nutrition education. There is no policy for nutrition education in Beninese schools and no nutrition education classes are incorporated in the curriculum. Hence, the adolescents said they receive no information on fruits and vegetables at school.

Competition of unhealthy foods. Private school students talked about the competition of unhealthy foods with fruits and vegetables at school. They said that foods like sweets and chocolate were more available and accessible in their schools than fruits and vegetables. In addition, these items were considered to be more attractive since they are nicely presented and packaged. The adolescents also thought that these foods are as healthy as fruits and vegetables. For instance, they would contain vitamins too. As a boy said:

'I dislike eating fruits outside home, but I like eating biscuits, it's [biscuits] my preferred food, I've just eaten for 200 francs [West African currency ≈0.30 euro]. I prefer biscuits to mangoes because biscuits are packaged (private school, third grade).'

Factors related to the home environment.

Availability and accessibility of fruits and vegetables. The availability and accessibility of fruits and vegetables were especially discussed with regard to the home environment. Two thirds of the

participants in private schools reported to have fruits at home everyday since their parents were used to buying some. In public schools, fewer students said to have fruits at home everyday. Fruits were usually provided by mothers but some students mentioned their fathers also brought fruits home. In most cases, vegetables were available less often at home. They were generally available after mothers (or other females in the house) have bought some at the market.

Half of the participants in public as well as private schools said they had fruit trees or vegetable plots or both at home. Vegetable plants at home were essentially green leafy vegetables like amaranth and *Vernonia* spp. However, only a few students were used to consuming home-grown fruits and vegetables. Sometimes, fruits and vegetables available at home were gifts from relatives.

Not only was the home availability of fruits and vegetables important. A greater accessibility increased consumption by the adolescents as well. From the discussions, it appeared that accessibility was ensured for instance by cooking and serving the adolescents ready-to-eat meals with vegetables or by putting fruits at their disposal and in sight. For instance, a student said:

'I have a mango tree at home but I don't eat the fruits because I don't like picking them. Other people [fruit vendors outside home] pick fruits and I buy (private school, fifth grade).'

Some public and private school students mentioned they were used to buying fruits in their neighborhood, outside their home and their school. The public school students also said they were used to eating vegetable meals, like maize dough with sauces of leafy vegetables, in restaurants near their house.

Parental influence. Parental influence emerged as a strong home-related determinant. Parents played an important role in the home availability and accessibility of fruits and vegetables. Parents were also influential through their own fruit and vegetable intake and the nutritional advice they give their children and established rules regarding home meals. A girl stated:

'I ate some fruit salad … mummy made some at home … daddy decides when we would eat some. And on evenings, I accompany mum who is on diet. I help her by eating fruits too (private school, third grade).'

Sometimes, parents rewarded their children for consuming fruits and vegetables.

'I don't particularly like vegetables but I eat some because of my mother and in return, I get some money or a gift (private school, fifth grade).'

The influence of parents was at times considered positively associated with the consumption of fruits and vegetables by the adolescents but at times also with a decreased consumption. A boy said:

'Sometimes, if you want to eat mangoes or pineapple, daddy or mummy would tell you not to eat and when you ask them why, they would tell you not to eat or you will have diarrhea or something [another disease]. Otherwise, when I wake up and see a fruit, I eat it (private school, fifth grade).'

PERSONAL FACTORS

Preferences. The most discussed personal factors were preferences, mostly taste. The influence of taste was perceived positive and made the adolescents eat more fruits and vegetables or it was considered negative at times. Most adolescents preferred sweet fruits, only few preferred acidic

taste. Many participants did not appreciate bitter vegetables like *Vernonia* spp. Some did not like particular fruits and vegetables they find tasteless, such as bush okra (*Corchorus* spp.) and watermelon.

Besides taste, participants mentioned various reasons for preferring or disliking particular fruits and vegetables such as their smell, their color, their shape or a bad or good experience when eating them.

'I like all kinds of fruits, except pineapple because it irritates my tongue (private school, fifth grade).'

'I eat amavivè [Vernonia spp] because I'm a sickly and it keeps me healthy, it also cures diabetes, but I dislike all other vegetables (public school, third grade).'

Some vegetables were appreciated or disliked because of the way they are prepared (ingredients used to cook them) or because of particular foods they are usually consumed with.

'I like cassava leaves because when they are cooked with peanut paste, it's very delicious (private school, third grade).'

'I don't like sauces prepared with leafy vegetables because you always eat them with dough (public school, third grade).'

Nutrition and health knowledge. The adolescents' nutrition and health knowledge was the most discussed personal determinant after their preferences. Globally, participants from the four schools had a good knowledge of the benefits of eating fruits and vegetables. Examples of statements are:

'When you cook vegetables, there is a loss of vitamins but you just have to wash fruits and eat (private school, fifth grade).'

'I like fruits because of their taste and I also heard that fruits and vegetables contain many vitamins. Okra contains some calcium (public school, third grade).'

'Fruits are good for a healthy and balanced diet. For a meal to be balanced, you should eat a fruit after it … Normally, we should eat five fruits and vegetables everyday (private school, third grade).'

A few students thought fruits and vegetables could also impede health or well-being.

'Fruits and vegetables are good for health but sometimes they can have bad consequences for health. For instance diabetes, when you exaggerate with bananas [eat too many bananas] (public school, third grade).'

Cultural beliefs. Some participants addressed the question of cultural beliefs. For instance:

'When you have many problems in your life or unluckiness, it is advised to eat fruits (private school, fifth grade).'

'Okra reduces the testicles and decreases memory (public school, fifth grade).'

BEHAVIORAL FACTORS

Eating patterns. The eating patterns of the adolescents were often mentioned. The consumption frequency of fruits and vegetables varied considerably. In most cases, fruits and vegetables were not consumed on a daily basis, except for tomatoes and onions which are commonly used to cook everyday meals. While students from private schools said they ate fruits and vegetables every week, those from public schools reported that some weeks they did not consume fruits.

Some adolescents mentioned a difference between weekdays and weekends. They ate more fruits and vegetables during weekends because there was more time for preparing vegetables or because parents brought more fruits home during weekends.

'Dad is used to buying fruits when he comes back home after work hours …not everyday. During weekends, he buys a lot and then I eat more fruits, even apples (public school, fifth grade).'

Some participants said they ate fruits at night because there are no more flies or because they digest better. Finally, most students reported to eat fruits usually as dessert.

'I eat mangoes after a good meal …for instance rice with meat, chicken or mutton, and if there's everything inside, carrots, green peas, cabbage (private school, third grade).'

Students said they ate fruits and vegetables more often at home because then they did not need to buy some themselves. Eating fruits and vegetables at home was also practiced for hygienic reasons. For instance:

'I eat fruits more at home because I can wash them correctly, remove my clothes and be at ease… and at home you can hide from flies (private school, fifth grade).'

OTHER FACTORS

Food safety, the cost of fruits and vegetables, convenience and time of preparing fruits and vegetables, medical prescription and media influence were also mentioned during the discussions and could constitute barriers to or promoters of a fruit and vegetable intervention.

Food safety. The hygienic quality of fruits and vegetables was frequently discussed. Some adolescents talked about particular fruits and vegetables that they perceived as non hygienic, no matter how there were cleaned or cooked. For that reason, they were reluctant to consume them.

'I don't like mangoes because of flies. Even if you clean them, you can get diarrhea or cholera or you can vomit… sometimes, there are worms inside mangoes (private school, third grade).'

'Some leafy vegetables grow close to the ground and ground worms and microbes stick to the leaves and they are cooked without cleaning (private school, fifth grade).'

Some participants mentioned they did not eat particular vegetables because of the way they are prepared, for instance the way some leafy vegetables are triturated by hand. To them, prepared vegetables were not hygienic. Students also pointed out that they eat fruits and vegetables more often at home for hygienic reasons. They were not confident in the food safety of fruits and vegetables outside home, particularly at school, and more concerning vegetables. For instance:

'I eat vegetables at home because there, you can be sure of the hygienic quality; you know how they are cooked (public school, fifth grade).'

Cost of fruits and vegetables. Students said the price of fruits and vegetables depends on seasonal availability.

'Fruits are not expensive, but it depends on the seasons, dry season or raining season. During the dry season, fruits are rare, during the raining season, they are available (private school, third grade).'

For students in private schools, the price was not considered a constraint to the purchase of fruits and vegetables. The students were used to buying fruits and even exotic fruits

(strawberries, raspberries, grapes) which are rare, expensive and generally sold in the supermarkets. However, in public schools, financial means were an important constraint, which explains why public school students reported to eat more fruits when they were at home than outside.

'I would like to eat more fruits, yes, if I had money. If I could eat fruits everyday, I would, if prices are reduced (public school, fifth grade).'

Convenience and time. The participants stated they preferred fruits to vegetables because fruits do not need cooking but only cleaning. Some fruits, like bananas, were even considered more convenient than others and some were very inconvenient because one needs to clean teeth and mouth after eating them. Some girls said they eat more vegetables during weekends because there is more time for cooking.

Medical prescription. Many public and private school students mentioned medical prescriptions as reasons for eating or not a fruit or vegetable. Examples of quotes are:

'I eat bananas. I'm ulcerous and the doctor advised them to me (public school, fifth grade).'

'My doctor forbade me to eat pineapples because of my hemorrhoids (public school, fifth grade).'

Media influence. Students from public as well as private schools reported they mainly received information about the health and nutrition benefits of fruits and vegetables from radio, television and journals but also through the Internet, movies, books, magazines and Beninese theatres.

'I like to eat fruits because the White [Caucasians] said that after eating some dough, one should eat dessert ... they say that in movies, also in Pipi's [a famous Beninese comedian] theatres (private school, fifth grade).'

POSSIBLE INTERVENTIONS

The majority of students preferred a school program on fruits only. They expressed important concerns regarding the hygienic quality of vegetable meals offered. Their first proposal for a fruit school intervention was to organize information sessions on fruits. Secondly, they proposed to increase school availability by installing fruit stalls with a variety of good quality (not spoiled), well protected and cheap fruits. The adolescents considered the regular school food vendors appropriate vendors for a school intervention. Their other proposals were: to organize taste testing sessions on new fruits; to distribute informative leaflets about particular fruits and to install a school garden. The participants highlighted the importance of associating their school authorities, teachers, food vendors and parents, and sensitizing all the students before starting any program. They also proposed to send informative leaflets to their parents although some said their parents are illiterate.

DISCUSSION

This study explored qualitatively the determinants of fruit and vegetable intake in adolescents in the context of Cotonou, an urban area in a LMIC. The study was conducted with

409 the view that the discussions with the adolescents will lead to the context-specific barriers and
410 opportunities to their consumption of fruits and vegetables and to the design of an appropriate
411 fruit and vegetable intervention.

412 Major home-related determinants retrieved from the focus groups were the availability
413 and accessibility of fruits and vegetables and parental influence. Important factors in the school
414 environment were availability and accessibility, nutrition education and competition of unhealthy
415 foods. Among the personal factors, preferences (mainly taste) and nutrition and health
416 knowledge were the most discussed determinants. The participants also referred to some cultural
417 beliefs. In Benin, the influence of cultural beliefs about foods, in particular fruits and vegetables,
418 is more pronounced in rural areas but is declining with modernization. These beliefs potentially
419 decrease or increase the consumption of certain fruits and vegetables. Eating patterns were
420 retained as the behavioral factors. Other important factors emerged from the discussions: medical
421 prescription, media influence, the cost of fruits and vegetables, convenience and time of
422 preparing fruits and vegetables and food safety.

423 Except food safety, the determinants from our study have already been largely discussed
424 in studies conducted in HIC. For instance, the availability and accessibility of fruits and
425 vegetables were identified as major factors influencing adolescents' fruit and vegetable
426 consumption both at home and at school[16;17]. Parental influence was also discussed[32]. In other
427 studies, taste also appeared among personal factors as a strong predictor of adolescents' fruit and
428 vegetable consumption or of their food choices in general[16;33]. Socioeconomic differences in fruit
429 and vegetable availability and accessibility[17] were confirmed, as the focus groups showed that
430 the financial means were an essential difference between private and public schools. This might
431 explain why public school students reported a lower home availability of fruits and vegetables

compared with private school students. The better-off parents might purchase fruits and vegetables in larger quantities or more frequently compared with parents of students in public schools. In addition to that, students in private schools had more pocket money and were used to buying more fruits themselves, even expensive exotic fruits. Consequently, a difference in the reported consumption frequency of fruits and vegetables between private and public schools was noted.

The interesting difference between our results and findings from HIC is that, in the context of Cotonou, food safety appeared as a strong barrier to the consumption of fruits and vegetables by the adolescents. This causes a reluctance to eat fruits and vegetables sold in school settings and in general outside home. In particular, they disliked eating vegetable meals at school, and in general outside home, because of bad hygiene. Provided food safety issues are addressed, schools were identified as appropriate settings for successful nutrition interventions in adolescents[19;20]. This offers interesting opportunities for health promotion activities in Benin, in particular since fruit and vegetable programs have shown to be effective in schools in HIC previously[21-23].

To get some information for the development of an intervention, we asked the participants themselves which school intervention they would like. A key constraint to set up a school program, in particular for the promotion of vegetables, was the hygienic conditions during food preparation. The adolescents also stated fruits were more convenient than vegetables. In addition, they estimated they already ate enough vegetables but not enough fruits. Barriers to a school fruit program that we identified are: low availability and accessibility of fruits in the schools, lack of nutrition education on fruits at school, competition of sweet foods, cost of fruits in the case of students from poor households and poor food safety. Some opportunities also exist:

455 the adolescents' willingness to eat more fruits, their willingness to learn more about fruits,
456 presence of natural science classes in the school curriculum in which notions on fruits could be
457 inserted and presence of school food vendors who could be associated to offering more fruits to
458 the students.

459 The use of focus groups in this study implies some limitations. Some students might have
460 not participated well in the discussions because there are shy or not used to such activities.
461 Therefore, our findings may reflect only the views of dominant participants[26]. However, as much
462 as possible, the moderator tried to establish a comfortable and friendly ambiance by starting with
463 table rounds on easy questions. He also encouraged an active participation of all the students
464 throughout the discussions. The moderator and his assistant were both Beninese with a good
465 knowledge of the cultural context and local languages and could relate well with the participants'
466 views and attitudes during the discussions. The same keyword guide was used for all the
467 discussions and allowed a standard but still flexible data collection. The number of focus group
468 sessions was defined a priori before the survey and was four per category of participants. This
469 number was judged sufficient to reach data saturation. Transcripts were done in French soon
470 after the focus groups and analyzed independently by two different researchers. No statistical
471 measure was calculated to appreciate inter-coder reliability; however a standard coding and
472 analysis procedure was applied by the two researchers and extensively discussed afterwards until
473 consensus was reached.

474 Yet, although our findings cannot be generalized[26], they provide valuable insight into the
475 determinants of fruit and vegetable intake in urban Beninese adolescents and for the
476 development of a well-tailored and efficient fruit and vegetable intervention in this population.
477 The conclusions of our study are that: the promotion of fruit and vegetable consumption in urban

Beninese adolescents at school may need to focus on food vendors in and around the school, parents have a major role to play in any intervention, and adolescents from poor families should be particularly targeted. Incorporating food safety concerns in fruit and vegetable interventions is a key issue to be studied in-depth for future development of interventions in Benin and potentially other LMIC.

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REFERENCES

(1) WHO. *Diet, nutrition and the prevention of chronic diseases. Report of a Joint WHO/FAO Expert Consultation*. Geneva: WHO; 2003.

(2) Popkin BM. The shift in stages of the nutritional transition in the developing world differs from past experiences! *Public Health Nutr* 2002; 5: 205-214.

(3) Abegunde DO et al. Chronic diseases 1 - The burden and costs of chronic diseases in low-income and middle-income countries. *Lancet* 2007; 370: 1929-1938.

(4) He FJ, Nowson CA & MacGregor GA. Fruit and vegetable consumption and stroke: meta-analysis of cohort studies. *Lancet* 2006; 367: 320-326.

(5) Key TJ, Allen NE, Spencer EA & Travis RC. The effect of diet on risk of cancer. *Lancet* 2002; 360: 861-868.

(6) Liu S et al. Fruit and vegetable intake and risk of cardiovascular disease: theWomen's Health Study. *Am J Clin Nutr* 2000; 72: 922-928.

(7) Riboli E & Norat T. Epidemiologic evidence of the protective effect of fruit and vegetables on cancer risk. *Am J Clin Nutr* 2003; 78[3]: 559-569.

(8) Rolls BJ, Ello-Martin JA & Carlton Tohill B. What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management? *Nutr Reviews* 2004; 62[1]: 1-17.

(9) World Cancer Research Fund. *Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective*. Washington, DC: American Institute for Cancer Research; 2007.

(10) Ruel MT, Minot N & Smith L. Patterns and determinants of fruit and vegetable consumption in sub-Saharan Africa: a multicountry comparison. Background paper for the Joint FAO/WHO Workshop on fruit and vegetables for health, 1-3 September 2004, Kobe, Japan. Geneva: WHO; 2005.

(11) Hall JN, Moore S, Harper SB & Lynch JW. Global Variability in Fruit and Vegetable Consumption. *Am J Prev Med* 2009; 36[5]: 402-409.

(12) Fagbohoun M. *Prévalence de l'inactivité physique et de la consommation insuffisante de fruits et légumes en population générale au Bénin en 2008. Thèse de Doctorat en Médecine*. Cotonou: Faculté des Sciences de la Santé; 2008.

(13) "Blinded for review" et al. Food, energy and macronutrient contribution of out-of-home foods in school-going adolescents in Cotonou, Benin. *Br J Nutr* 2010; 103: 281-288.

(14) Gordon-Larsen P, Adair LS, Nelson MC & Popkin BM. Five-year obesity incidence in the transition period between adolescence and adulthood: the National Longitudinal Study of Adolescent Health. *Am J Clin Nutr* 2004; 80: 569-575.

(15) Gortmaker SL, Must A & Perrin JM. Social and economic consequences of overweight in adolescence and adulthood. *N Engl J Med* 1993; 329: 1008-1012.

(16) Neumark-Sztainer D, Wall M, Perry C & Casey MA. Correlates of fruit and vegetable intake among adolescents. Findings from Project EAT. *Prev Med* 2003; 37: 198-208.

(17) Rasmussen M et al. Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: quantitative studies. *Int J Behav Nutr Phys Act* 2006; 3[22].

(18) Pomerleau J, Lock K, Knai C & McKee M. Interventions designed to increase adult fruit and vegetable intake can be effective: a systematic review of the literature. *J Nutr* 2005; 135: 2486-2495.

(19) Delisle H, Chandra-Mouli V & De Benoist B. Should adolescents be specifically targeted for nutrition in developing countries? To address which problems, and how? 2001. www.who.int/child-adolescent-health/New_Publications/NUTRITION/Adolescent_nutrition_paper.pdf

(20) Katz D et al. Strategies for the prevention and control of obesity in the school setting: systematic review and meta-analysis. *Int J Obes* 2008; 32: 1780-1789.

(21) Bere E, Veierbd M & Klepp KI. The Norwegian School Fruit Programme: evaluating paid vs. no-cost subscriptions. *Prev Med* 2005; 41: 463-470.

(22) Bere E, Veierbd M, Bjelland M & Klepp KI. Free school fruit - sustained effect 1 year later. *Health Educ Res* 2006; 21: 268-275.

(23) Bere E, Veierbd M, Skare O & Klepp KI. Free school fruit - sustained effect three years later. *Int J Behav Nutr Phys Act* 2007; 4:5.

(24) De Sa J & Lock K. Will European agricultural policy for school fruit and vegetables improve public health? A review of school fruit and vegetable programs. *Eur J Public Health* 2008; 18: 558-568.

(25) French S & Stables G. Environmental interventions to promote vegetable and fruit consumption among youth in school settings. *Prev Med* 2003; 37: 593-610.

(26) Krueger RA & Casey MA. *Focus Groups: A Practical Guide for Applied Research*. Thousands Oaks: Sage Publications; 2009.

(27) Baranowski T, Weber Cullen K & Baranowski J. Psychosocial correlates of dietary intake: advancing dietary intervention. *Annual Rev Nutr* 1999; 19: 17-40.

(28) Geller KS, Dzewaltowski DA, Rosenkranz RR & Karteroliotis K. Measuring Children's Self-Efficacy and Proxy Efficacy Related to Fruit and Vegetable Consumption. *J Sch Health* 2009; 79: 51-57.

(29) Lytle LA et al. Predicting Adolescents' Intake of Fruits and Vegetables. *J Nutr Educ Behav* 2003; 35: 170-178.

(30) Reynolds KD, Hinton AW, Shewchuk RM & Hickey CA. Social Cognitive Model of Fruit and Vegetable Consumption in Elementary School Children. *J Nutr Educ* 1999; 31: 23-30.

(31) Pope C, Ziebland S & Mays N. Qualitative research in health care: analysing qualitative data. *BMJ* 2000; 320: 114-116.

(32) Young EM, Fors SW & Hayes DM. Associations between perceived parent behaviors and middle school student fruit and vegetable consumption. *J Nutr Educ Behav* 2004; 36: 2-12.

(33) Neumark-Sztainer D, Story M, Perry C & Casey MA. Factors influencing food choices of adolescents: findings from focus-group discussions with adolescents. *J Am Diet Assoc* 1999; 99: 929-934, 937.